Biological Control Investigations on Christmas Berry (Schinus terebinthifolius) and Emex (Emex spp.)

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Christmas berry (*Schinus terebinthifolius* Raddi, Anacardiaceae) and emex [*Emex australis* Steinh. and *E. spinosa* (L.) Campd., Polygonaceae] are important weeds of Hawaiian rangelands. This paper briefly records some investigations on insects attacking these plants in their native countries during the past several years and the introduction into Hawaii of selected species.

Among those who helped me in this work I would like to mention especially Francisco Azevedo e Silva, entomologist of the Forest Service in Portugal; John J. Drea, Jr. and Thomas B. O'Connell, U.S. Department of Agriculture entomologists in Rabat, Morocco; H. K. Munro, entomologist, South Africa Department of Agriculture; and Jose Pinto da Fonseca, entomologist, Instituto Biologico, Sao Paulo, Brazil. Most of the insect identifications were made by specialists of the Entomology Research Division, U.S. Department of Agriculture, Washington, and the Commonwealth Institute of Entomology, London.

Propagation, testing, and liberation of approved insects sent to Hawaii were carried out by Q. C. Chock, C. J. Davis, H. K. Nakao, Mabel Chong, and other members of the Entomology Branch, State Department of Agriculture., Honolulu.

CHRISTMAS BERRY (SCHINUS TEREBINTHIFOLIUS RADDI)

This tree is native to Brazil, Paraguay and northern Argentina but is now grown in many other tropical regions as an ornamental. In Hawaii it has become a serious pest on grazing land, especially on the island of Hawaii.

INSECTS INTRODUCED INTO HAWAII

Three species of *Schinus terebinthifolius* insects were liberated in Hawaii:

Episimus sp. (Olethreutidae). Larvae of this moth feed on the leaves and web them together. It is widespread in Brazil. Two lots collected at Salvador, Bahia and two lots from Rio de Janeiro were sent to Honolulu in July 1954. The first releases were made in 1954 at Naalehu, Hawaii

(December) and on Oahu. First releases on the other islands were made as follows: Pukoo, Molokai, January 1955; Haiku, Maui, October 1956; and Kapahi Homestead and Koolau, Kauai, October 1956. The moth was found well established at Kahaluu, Oahu on September 15, 1957. It is now widely distributed but not of much importance in controlling the plant. It is parasitized in Hawaii by the braconid *Bracon omiodivorum* (Terry); in Brazil I found it parasitized by an *Apanteles* and a *Bracon*.

Crasimorpha sp. (Gelechiidae). The caterpillars of this Brazilian moth form galls in the terminal parts of the branches. I found it at Guapituba and Ribeirao Pires in Sao Paulo state, Salvador in Bahia, and Recreio dos Bandeirantes in Guanabara. Several shipments were sent to Honolulu from these places in April–July 1954, but propagation was not successful with this material nor with a shipment from the Recreio dos Bandeirantes sent by Dr. J. C. M. Carvalho of the Museu Nacional, Rio de Janeiro, in May 1955. In June–October, 1961 I sent many galls from Recreio dos Bandeirantes, and a few from Maua and Mongagua, Sao Paulo to Honolulu. These were propagated and the first release was made at Kiolakaa, Kau, Hawaii on December 13, 1961. At the Recreio dos Bandeirantes, the ichneumonid *Ephialtes* (*Calliephialtes*) *gallicola* Costa Lima and the encyrtid wasp *Copidosoma* sp. were bred from this species.

Bruchus atronotatus Pic (Bruchidae). This beetle breeds in the seeds. In March–June 1954, 20 shipments of seeds collected at Guapituba, Ribeirao Pires and Maua in Sao Paulo state were sent to Honolulu. These were heavily infested but propagation was not successful. In March–April 1955 and in March–April 1960 material collected in Sao Paulo state by Dr. J. Pinto da Fonseca of the Instituto Biologico, Sao Paulo was received. The first releases from this material were made in Kau, Hawaii and Heeia, Oahu on April 26, 1960. I made further shipments from Sao Paulo and Maua in Sao Paulo state in April 1961 and beetles from these were released in Kiolakaa, Kau, Hawaii on April 25. The bruchid was found established at Kiolakaa in August 1962 and at Heeia, Oahu in October 1962. This is a promising insect and it should be very destructive of the seeds. In Brazil the following parasitic Hymenoptera were bred from infested seeds: *Horismenus* sp. (Eulophidae), *Eurytoma* sp. (Eurytomidae) and *Zatropis* sp. (Pteromalidae).

Other Insects From Schinus Terebinthifolius

Many other species of insects were found on Christmas berry and a few of these are listed here. All are from Brazil except as noted otherwise.

HOMOPTERA

Psyllidae

Calophya sp. At various places in the states of Rio de Janeiro, Sao Paulo and Minas Gerais, Feb.-May, on leaves.

LEPIDOPTERA

Amatidae

Species ? Curitiba, Parana, July, caterpillars feeding on leaves.

Arctiidae

Species ? San Ignacio, Misiones, Argentina, May, caterpillars feeding on leaves.

Geometridae

Leptolopha sp. Curitiba, Parana, Sept.; Vitoria, E. S., June; larvae feeding on leaves.

Gracilariidae

Gracilaria sp. Salvador, Bahia, Oct., larvae forming blotch mines in leaves.

Near **Parornix** sp. Sao Vicente, S. P., Sept., larvae mining leaves.

Megalopygidae

Megalopyge sp., doubtfully **pixidifera** (J. E. Smith). Weslaco, Texas, Nov., larvae feeding on leaves.

Lacosomidae

Species ? Curitiba, Parana, Sept., larvae webbing and feeding on leaves. The pentatomid bug *Podisus saggitatus* F. was observed feeding on the larvae.

Limacodidae

Phobetron sp. [near or = *hipparchia* (Cramer)]. Paqueta I., Rio de Janeiro, June, larvae feeding on leaves.

Sibine sp. near **rufescens** Walker. Itapoan, Bahia, Oct., gregarious larvae feeding on leaves. The larvae have irritating spines. Parasitized by the bombylid fly *Systropus conopoides* Kunckel d'Herculais.

Notodontidae

Nystalea ebales (Cramer). Salvador, Bahia, July, larvae feeding on leaves.

Phalaenidae

Atethmia subusta Hübner. Universidade Rural, Rio de Janeiro state, March, larvae feeding on leaves.

Paectes sp. Universidade Rural, Rio de Janeiro state, March; San Ignacio, Misiones, Argentina, May; larvae feeding on leaves.

Phycitidae

Cryptoblabes gnidiella (Milliere). Sao Paulo, S.P., April on plants. Larvae of this moth are known to feed on honeydew.

Psychidae

Oiketicus geyeri Berg. Curitiba, Parana, July, larvae in smooth cases feeding on leaves.

Oiketicus kirbyi Guilding. Curitiba, Parana, July, larvae in rough cases feeding on leaves.

Riodinidae

Emesis sp. Guapituba, S.P., March, larvae feeding on leaves.

Saturniidae

Hylesia sp. Belo Horizonte, M.G., July, gregarious caterpillars under webs on trunks; feeding on leaves. The caterpillars have irritating spines.

Sphingidae

Protambulyx strigilis (L.). Guapituba, S.P., April; Sao Paulo, S.P., Nov.; larvae feeding on leaves.

Tortricidae

Eulia sp., near **quinquenotata** (Walker). Belo Horizonte, M.G., April, larvae feeding on leaves.

Eulia sp., near **virga** Clarke. Guapituba, S.P., March, larvae feeding on leaves.

Zanolidae

Species ? Curitiba, Parana, July, larvae feeding on leaves.

COLEOPTERA

Curculionidae

Apocnemidophorus sp. Itanhaen and Maua, S.P., Oct., adults feeding on leaves.

Attelabus sp. Guapituba and Ribeirao Pires, S. P., May, adults feeding on tender young leaves.

HYMENOPTERA

Argidae (Sawflies)

Species ? Curitiba, Parana, larvae feeding on leaves.

Formicidae

Atta sexdens (Linn.). Recreio dos Bandeirantes, Gb., Aug., cutting leaves.

Pergidae (Sawflies)

Heterosperryia jorgensi (Schrottky). San Ignacio, Misiones, Argentina, May, larvae feeding on leaves.

DIPTERA

Cecidomyiidae

Species ? Sao Vicente, S.P., Sept., larvae forming galls on tender young leaves. Parasitized by the platygasterid wasp *Leptacus* sp.

Some Insects on Other Species of Schinus

COLEOPTERA

Bruchidae

Lithraea electus Bridwell (Synonym—*Bruchus elegans* Blanchard) Las Cruces, near Cartagena, Chile, May, ex seeds *Schinus latifolius.*

Chrysomelidae

Procalus mutans viridis (Philippi). Las Cruces, near Cartagena, Chile, April, larvae feeding on leaves *Schinus latifolius.*

EMEX AUSTRALIS STEINH. AND E. SPINOSA (L.) CAMPD.

These two closely related low-growing plants have seed pods with three strong spines at the apex. They became established in Hawaii in recent years. *E. australis* is believed to be native to southern Africa but is also widespread in Australia; *E. spinosa* is from the Mediterranean region.

E. spinosa was abundant in the Belem section of Lisbon and in sandy soil on hillsides and at a valley bottom at Praia das Macas on the coast of Portugal, and in wasteland and along the sides of streets in Rabat, Morocco. At Praia das Macas small seedlings about three or four inches high were observed in November. In both Portugal and Morocco, large lush plants with flowers and seed pods were found during March and April, but in May many were already dead. The plants dry up completely during the summer. Many plants, mostly dead, were found on a farm at San Andreas, Tenerife, Canary Islands in May 1962.

Lush green plants of *Emex australis* were observed in the Stamford Hill Aerodrome area of Durban, Natal, South Africa from November 1956 to February 1957. Small plants were found in fields at Old Umtali, Southern Rhodesia in March 1957 where it has been a serious pest in barley fields. In South Africa this weed is known as devil's thorn, Duilweltjies or Dubbeltjies. The Zulus in Natal call it nkunzana (little bull).

EMEX INSECTS INTRODUCED INTO HAWAII

Apion antiquum Gyllenhal. The larvae of this weevil bore in the branches and stems and the adults feed on the leaves. During December 1956–February 1957, 12 lots of immature stages in the branches and adults collected on *Emex australis* in the Stamford Hill Aerodrome area of Durban, Natal were sent to Honolulu. The first release was on Parker Ranch, Hawaii on January 24, 1957, and other releases on Molokai Ranch, Molokai on March 8, 1957 and at Pukalani, Maui on April 4, 1960. The first recovery was made on Parker Ranch in October 1958 and the beetle is now also established on Oahu and Maui. Many *E. australis* plants have been destroyed by heavy attack by the beetles on Parker Ranch and this species shows great promise.

Apion violaceum var. **harcyniae** Hübenthal. This weevil attacks *E. spinosa* in the same manner as the preceding. Three lots of immature stages in stems and adults collected at Praia das Macas, Portugal in April-May 1960, and 9 lots collected there in March–May 1962 were sent to Honolulu. The first releases were made at Omaopio and Waiakoa, Maui on April 16, 1962.

Apion neofallax Warner. This weevil, which attacks *E. spinosa* in the same way as the two preceding species, was collected in Morocco by C. J. Davis in 1957 and 1958. Several shipments were made to Honolulu but the weevils were not not released. In May–June 1960 I sent four shipments

of immature stages in the stems and adults collected on the plants, and in April–May 1962 a further eight shipments, to Honolulu. These were all from Rabat, Morocco. Releases were made at Omaopio, Maui on May 29, 1962 and at Waiakoa, Maui on June 7, 1962.

Other Insects on Emex

Some of the other species of insects found associated with emex are listed below. In addition to these, spittle bugs, scales, mealybugs and several species of caterpillars feeding on the leaves were found.

HETEROPTERA

Coreidae

Haploprocta sulcicornis (F.). Praia das Macas, Portugal. April 1962, on *E. spinosa*.

HOMOPTERA

Aphidae

Anuraphis emicis Mimeur. Praia das Macas, Portugal, April and May 1962, on stems of *E. spinosa*.

Aphis fabae Scopoli. Durban, Natal, South Africa, Nov. 1956, on leaves *E. australis*.

Aphis sp., **fabae** Scopoli complex. Tangier, Morocco, May 1960, on stems *E. spinosa*.

LEPIDOPTERA

Pyralidae, Phycitinae

? **Myelois** sp. Durban, Natal, South Africa, Nov. 1957, caterpillars feeding on leaves *E. australis*.

Sphingidae

Celerio galli (Rottenburg). Rabat, Morocco, May 1960, caterpillars feeding on leaves *E. spinosa*.

COLEOPTERA

Curculionidae

Alcidodes sp. Old Umtali; Southern Rhodesia, March 1957, larvae boring in live branches *E. australis*.

Lixus algirus Linn. Abundant on *E. spinosa* at Praia das Macas, Portugal. The larvae bore in the stems and branches and hollow them out. The eggs are placed singly in cavities bored in the stems. Eggs and larvae were found in March and April and the larvae were well developed in May. This weevil attacks various other plants.

Lixus ferrugatus (Olivier). This insect attacks *E. spinosa* at Rabat, Morocco and works in a similar way to the preceding species. Eggs and larvae were noted in the stems in April, and in May there were many large larvae, pupae and newly developed adults.

Sciobius brevicollis Fahrs. Durban, Natal, South Africa, Dec. 1957, adults feeding on leaves of *E. spinosa*; also feeding on leaves of *Lantana camara*.

Sitona lineatus (Linn.). Praia das Macas, Portugal, May 1962, in *E. spinosa*.

DIPTERA

Anthomyiidae

Pegomyia sp., probably **bicolor** Wiedemann. Rabat, Morocco, April 1962, larvae forming blotch mines in leaves of *E. spinosa*.

FUNGUS

A leaf spot caused by *Cercospora tripolitana* Sacc. and Trott. was found on *Emex australis* at Old Umtali, Southern Rhodesia in March 1957 (det. Commonwealth Mycological Institute, Kew).

PUBLICATION ANNOUNCEMENT

A Review of the Machaerotidae (Hemiptera: Cercopoidea), by T. C. Maa. Pacific Insects Monograph 5, July 1963. 220 pages, 35 figures. $5.00 bound $4.25 unbound.

A comprehensive treatment of the entire family, based upon a study of 1200 specimens from 34 collections. The family is divided into 2 subfamilies, 4 tribes, and 27 genera. Six genera and 1 subgenus are described as new; 7 generic names are synonymized; 107 species are considered distinct, including 31 new ones, with a number of new synonyms and combinations. A phylogenetic hypothesis is presented, and five cases of stylopization, as well as other biological data, are reported.